PATENT
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant: Michael Wojtowicz)	*"Certificate of Mailing"*
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Serial No.: 09/833,372)	being deposited with the United States
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Filed: April 12, 2001)	envelope addressed to:
)	Mail Stop Appeal Brief-Patents
Title: GaN HBT SUPERLATTICE BASE)	Commissioner for Patents
STRUCTURE)	P.O. Box 1450
)	Alexandria, VA 22313-1450
)	
Group Art Unit: 2815)	Jan 20, 04 — John S Paniaguas
)	Date — John S. Paniaguas
Examiner: Baumeister, Bradley W.)	Reg. No. 31,051
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Customer No.: 27160)	

APPEAL BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith for the above-identified application are the following:

1. Three copies of an Appeal Brief;

2. The Commissioner is hereby authorized to charge any additional fees which may be required in this application under 37 C.F.R. §§1.16-1.17 during its entire pendency, or credit any overpayment, to Deposit Account No. 50-1214. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 50-1214. This sheet is filed in triplicate.

Respectfully submitted,

KATTEN MUCHIN ZAVIS ROSENMAN

John S Paniaguas

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Registration No.: 31,051

Date: Jan 20, 04

Attorney Docket No. 211467-00211

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant(s):	Wojtowicz	)
Serial No.:	09/833,372	)
Filed:	April 12, 2001	)
Title:	GaN HBT Superlattice Structure	)
Group Art Unit:	2815	)
Examiner:	Baumeister, Bradley W.	)

Applicant's Brief On Appeal

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Real Party In Interest

The real party in interest is Northrop Grumman Corporation, by virtue of an Assignment from the inventor Michael Wojtowicz to TRW Inc., recorded on Reel/Frame 11702/297 and from TRW, Inc., to Northrop Grumman Corporation recorded on Reel/Frame 013751/0849.

Related Appeals and Interferences

There are no other appeals or interferences known to the Appellant or the Appellant's representative, which are believed to directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

Status Of Claims

Claims 1-5 and 8-11 are pending. The final rejection of these claims forms the basis for this appeal. In particular, claims 1, 8 and 9 stand rejected under 35 U.S.C. §103 as being unpatentable over Song U.S. Patent No. 6,410,944 ("Song") in view of Chow U.S. Patent No.

6,320,212 ("Chow"). Claims 1, 5, 8 and 9 stand rejected under 35 U.S.C. 103(a) as being unpatentable over the Song and Chow patents and further in view of Razeghi U.S. Patent No. 5,831,277 ("Razeghi"). Claims 2-4, 10 and 11 stand rejected under 35 U.S.C. 103(a) over the Song and Chow patents (or collectively the Song, Chow and Razeghi patents) further in view of Ohta U.S. Patent No. 4,620,206 ("Ohta").

Status Of Amendments

An amendment and is being file concurrently with the Appeal Brief in accordance with MPEP § 1207 which should obviate the Examiner's objection to paragraph [00005] of the Specification.

Summary Of The Invention

The present invention relates to a heterojunction bipolar transistor (HBT) 20 having a relatively higher efficiency and higher frequency operation without the fabrication complexities of known HBTs. The HBT 20 includes a substrate 22, a n^+ gallium nitride (GaN) subcollector 24 formed on top of the substrate 22. An n- GaN collector layer 26 is formed on top of the subcollector layer 24. In accordance with an important aspect of the invention, a base layer 28 is formed with non-constant band gap energy with a relatively low value at the collector base interface 30 and a higher value at the emitter base interface 32 in order to create an electrostatic field in the base to increase the carrier velocity and decrease the transit time of the device. The base layer 28 is formed from a superlattice consisting of alternating layers of AlGaN/GaN. An emitter layer is 34 is formed on top of the base layer 28. The emitter layer 34 is formed from AlGaN. A collector contact 36 is formed on top of the subcollector layer 34 while a base contact 38 is formed on top of the base layer 28. An emitter contact 40 is formed on top of the emitter layer 34. The configuration of the device increases the injected electron transit time and at the same time increases the p-type carrier concentration to improve the operation efficiency of the device.

Issues on Appeal

I. Whether the Board should reverse the rejection of claims 1, 8 and 9 under 35 U.S.C. 103(a) as being unpatentable over the Song and Chow patents.

II. Whether the Board should reverse the rejection of claims 5 (and claims 1, 8 and 9 alternatively) under 35 U.S.C. 103(a) as being unpatentable over the Song and Chow patents and further in view of the Razeghi patent.

III. Whether the Board should reverse the rejection of claims 2-4, 10 and 11 under 35 U.S.C. 103(a) as being unpatentable over the Song and Chow patent (or alternatively the Song, Chow and Razeghi) further in view of the Ohta patent.

Grouping of Claims

It is respectfully submitted that the claims stand or fall together.

Argument

I. Rejection of Claims 1, 8 and 9 under 35 U.S.C. §103(a) as being unpatentable over the Song and Chow patents.

Claims 1, 8 and 9 have been rejected under 35 U.S.C. §103(a) as being unpatentable over the Song patent in view of the Chow patent. The claims at issue all relate to a heterojunction bipolar transistor (HBT) based on a GaN/AlGaN material system. For the convenience of the Board, FIG. 1 from the Applicant's specification is reprinted below.

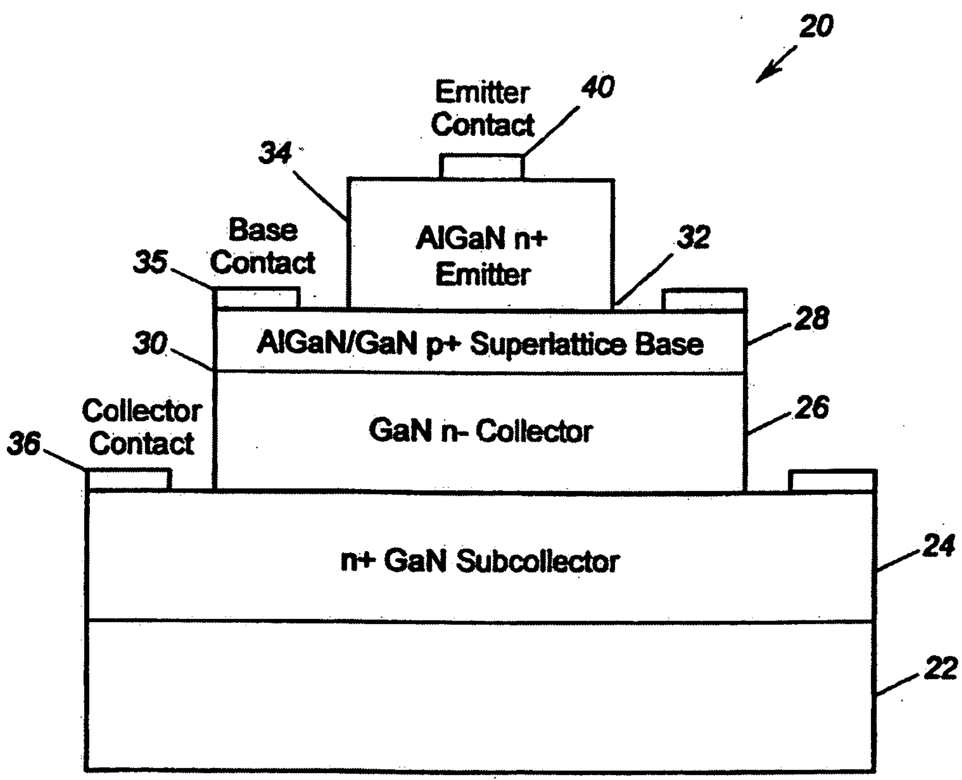
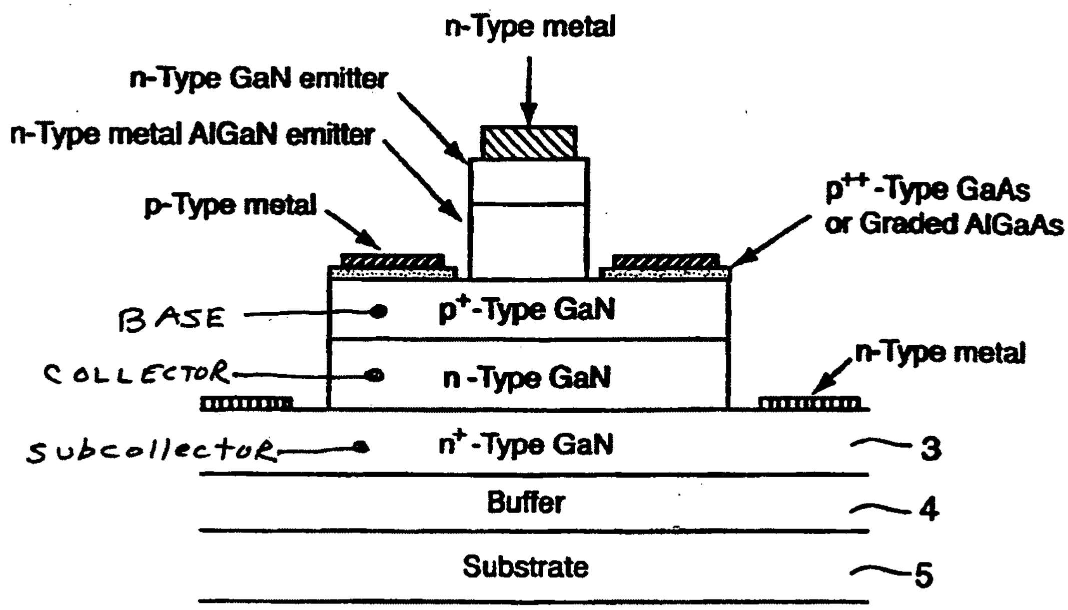


FIG. 1

An important aspect of the invention relates to the base layer 28 formed from a supperlattice of alternating layers of AlGaN/GaN.

The primary reference is the Song patent. In the final Office Action, mailed on March 20, 2003, the Examiner relies on FIG. 3 of the Song patent in support of the rejection. For the convenience of the Board, FIG. 3 of the Song patent is illustrated below.[1/]

FIG. 3



As the Board will kindly note, the Song patent discloses a P^+ GaN base layer, in contradistinction to the AlGaN/GaN superlattice base layer recited in the claims at issue. There are also other differences between the structure disclosed in the Song patent and the invention. In particular, the Song patent discloses a two layer emitter with one layer formed from AlGaN and a second layer formed from GaN. The invention, on the other hand, discloses a homogenuous emitter layer formed from AlGaN.

The Examiner cites the Chow patent for teaching that HBTs may be provided with superlattices which the Examiner alleges in paragraph 3(b) of the Detailed Action "so that the effective band

1/ The Applicant has identified the base, collector and subcollector layers of FIG. 3 of the Song patent in the same manner as identified in paragraph 3(a) of the Detailed Action.

gap of the base decreases from the emitter side to the collector side for improving electron drift across the base and that the bands of the base and the emitter can be aligned (e.g., FIG. 4 and col. 6, lines 23-24)".

FIG. 4 of the Chow patent is repeated below for the convenience of the Board.

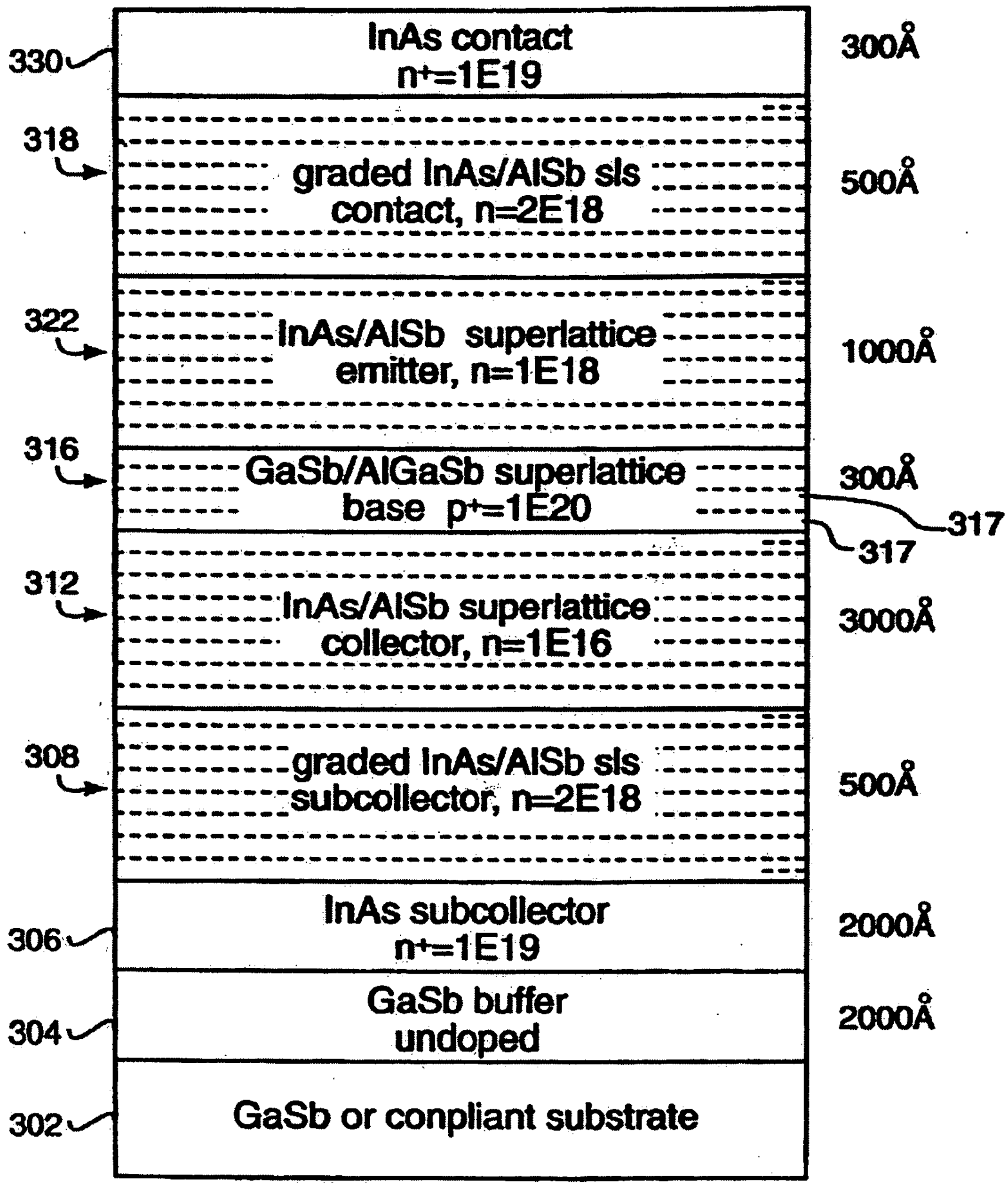


FIG. 4

Sch matic layer sequence diagram of th
InAs/AlSb/GaSb-based HBT structure.

The Board is kindly requested to note that the Chow patent discloses a different material system than the device recited in the claims at issue and, in particular, a GaSb/InAs/AlSb material system. With reference to FIG. 4 of the Chow patent, the Chow patent discloses a superlattice **collector** formed from InAs/AlSb; a superlattice **base** layer formed from GaSb/AlGaSb; as well as a superlattice **emitter** layer formed from InAs/AlSb as well as graded subcollector and contact layers formed from InAs/AlSb.

The Applicant respectfully requests the Board to note that neither the Chow patent nor the Song patent disclose a base superlattice layer as recited in the claims at issue, i.e., formed from AlGaN/GaN. Notwithstanding the Examiner opines in paragraph 3(b) of the Detailed Action that "it would have been obvious to have employed a superlattice specifically composed of AlGaN/GaN because Song discloses an emitter composed AlGaN and a collector composed of GaN, so using these specific materials in the superlattice would enable good lattice matching between the emitter, base and collector and would allow alignment of the base and emitter bands."

It is respectfully submitted that it appears that the Examiner is impermissibly using the Applicant's as a blueprint in order to support the rejection under 35 U.S.C. 103 on a piecemeal basis. First of all, nowhere does the Examiner point out where the references disclose or suggests the use of a AlGaN/GaN superlattice base layer. As mentioned above, the AlGaN base layer in accordance with the present invention induces an electron static field across the base layer and increases the velocity of the electron ejected from the emitter into the base. The device in accordance with the present invention, thus decreases the injected electron transit time and at the same time increases the p-type carrier concentration to improve the operating efficiency of the device. None of the references including the Song and Chow references disclose or suggest a system for inducing an electrostatic field across the base layer in the matter taught by the invention in order to increase the device performance.

Accordingly, it is respectfully submitted that the Examiner has failed to establish a *prima facie* case of obviousness as set forth in MPEP § 2142 and § 2143. In order to establish a *prima facie* case of obviousness, three criteria must be met as set forth in MPEP § 2143.

> "First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.
>
> "The teaching or suggestion to make the claimed combination reasonable expectation of success must both be found in the prior art, not in the Applicant's disclosure.

As discussed above, none of the references disclose or suggest a AlGaN/GaN superlattice base for use in an AlGaN material system. The Examiner simply states in paragraph 3(b) of the Detailed Action and states that "it would have been obvious to have employed a superlattice specifically composed of AlGaN/GaN because Song discloses an emitter composed of AlGaN formed from AlGaN and a collector composed of GaN." The Song reference clearly does not disclose AlGaN/GaN superlattice. Clearly, the Examiner has not shown that any of the references disclose a AlGaN/GaN superlattice base layer as recited in the claims at issue. The Examiner simply states without support that "using these specific materials in the superlattice would enable good lattice matching between the emitter, base and collector, and would allow alignment of the base and emitter bands." It is respectfully submitted that the Examiner attempts to bootstrap his rejection based on the Chow patent which discloses the use of superlattices for not only the base layer but also the collector and emitter layers. Moreover, the Chow patent is based on a different material system and does not disclose or suggest the superlattice recited in the claims at issue. Indeed, the Chow patent is based on a InAs/AlSb/GaSb/AlGaSb material system. As is known in the art, different materials have different properties. As such, the teachings are not transferable to the extent suggested by the Examiner.

In rebuttal, the Examiner has opined that the Applicant's reading of Song is too narrow. However, the Applicant simply notes the difference between the Song patent and notes that the Song patent discloses a base layer formed from a homogenuous layer of GaN. The Examiner further argues that nothing in the Chow patent says that the ***disclosed*** superlattice could not be used in other material systems. It is respectfully submitted that there are several flaws in this logic. First, it is respectfully submitted that the Chow patent does not disclose a superlattice formed from AlGaN/GaN. Rather, the Chow patent discloses an InAs/AlSb superlattice for the emitter; a GaSb superlattice for the base; and an InAs/AlSb superlattice for the collector. None of the superlattice structures disclosed in the Chow patent are being claimed in the claims at

issue. For these reasons, and all of the above reasons, the Board is respectfully requested to reverse the Examiner's rejection of claim 1, 8 and 9.

II. Rejection of Claim 5 (and alternatively Claims 1, 8 and 9) under 35 U.S.C. § 103(a) as being Unpatentable over Song/Chow Further in View of Razeghi.

Claim 5 (and claims 1, 8 and 9 alternatively) have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Song and Chow patents further in view of the Razeghi patent.

Claim 5 is similar to claim 1, and alternatively recites that the substrate is formed from materials selected from the group consisting of sapphire and silicon carbide.

As set forth in paragraph 4 of the Detailed Action, the Razeghi patent was cited as "further evidence that it was known at the time of the invention by those skilled in the art how to form a P^+ AlGaN/GaN superlattice". The Applicant respectfully disagrees with the Examiner's characterization of the Razeghi patent. In particular, the Razeghi discloses the formation of an $Al_xG_{1-x}N$/GaN heterostructure $0 \leq x \leq 1$. For x = 0, the heterostructure is GaN/GaN. The heterostructure is AlN/GaN for x = 1. As the Board can plainly acknowledge, there is no value of x which produces a heterostructure AlGaN/GaN.[2] Thus, even though the Razeghi patent discloses the use of superlattices, it plainly does not disclose a AlGaN/GaN superlattice layer and definitely does not disclose such a superlattice layer for the base.

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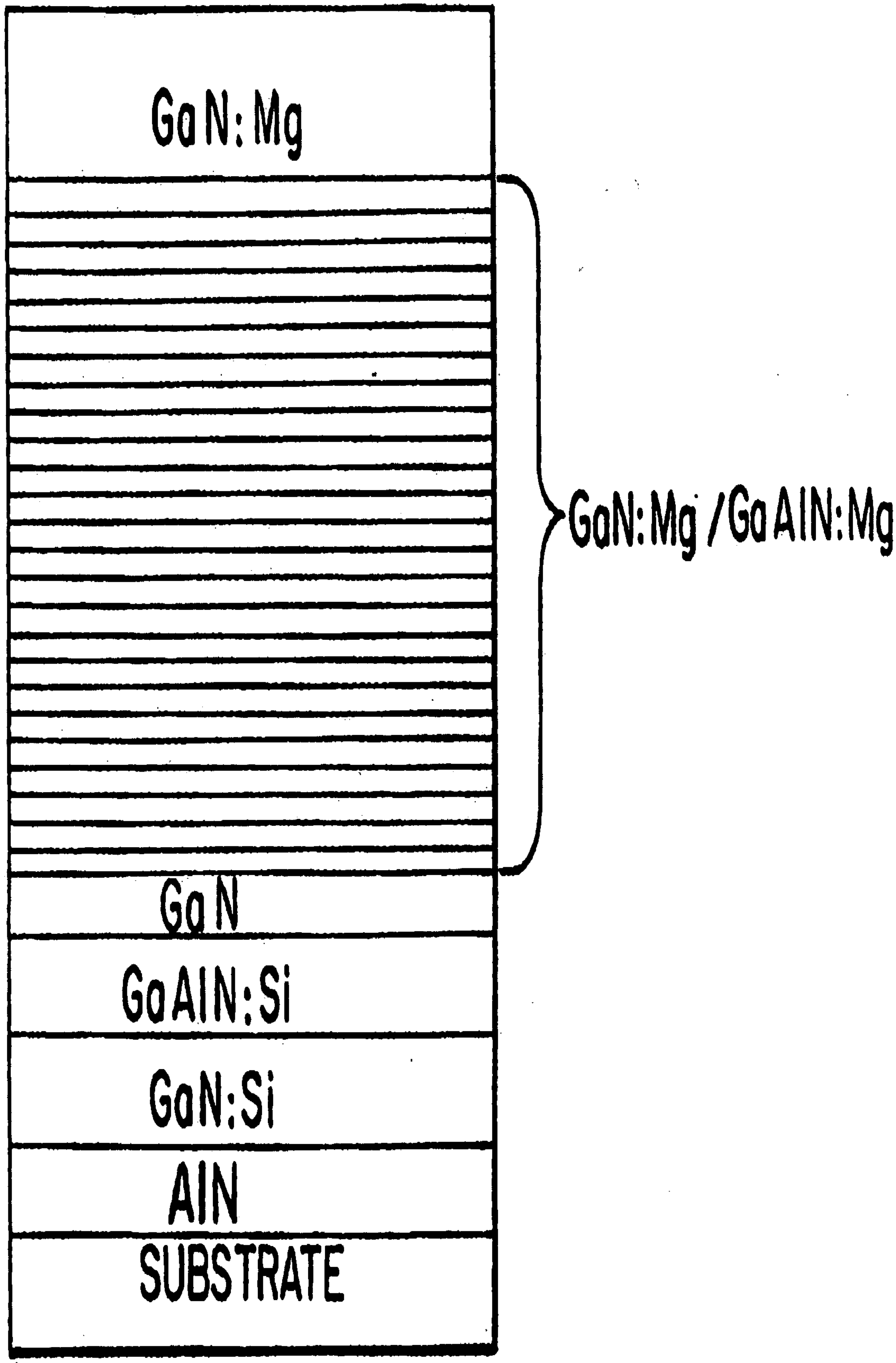
[2] However, the Applicant acknowledges fractional values are possible (i.e. $Al_{.3}G_{.7}N$/GaN). However, such a heterostructure is not being claimed.

The sole figure of the Razeghi layer is repeated below for the convenience of the Board.



Again, it is respectfully submitted that none of the references including the Razeghi reference disclose or suggest the specific superlattice layer of AlGaN/GaN recited in the claims at issue. For these reasons and the above reasons, the Board is respectfully requested to reverse the Examiner's rejection of claim 5.

III. Rejection of Claims 2-4, 10 and 11 under 35 U.S.C. § 103(a) as being unpatentable over Song/Chow (or alternatively Song/Chow/Razeghi) further in view of the Ohta patent.

Claims 2-4, 10 and 11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the Song and Chow patents (or alternatively Song/Chow/Razeghi) further in view of the Ohta patent. The Ohta patent was cited for teaching "that either barrier-thickness-grating or barrier-composition-grating can be employed in superlattices to produce effective band-gap changes in superlattice structure (See e.g., FIGs. 14-21)." The Examiner opines that "it would have been obvious to one of ordinary skill in the art at the time of the invention to have employed barrier-grading as taught by Ohta instead of the CHIRPing in the superlattice taught by Song/Chow or alternatively Song/Chow/Razeghi because the two grading schemes are functionally equivalent, both conventionally known at the time of the invention and because the barrier-grading enables the use of a constant thickness (i.e., thinner) barrier and well layers and does not require taking into account the change of each barriers and wells respective thicknesses for design calculations".

It is respectfully submitted that the Examiner's logic is flawed. In particular, it is respectfully submitted that the Examiner is undermining his own rejection of the claims in light of the Song/Chow and Song/Chow/Razeghi patents by stating that Ohta teaches barrier-grading instead of the CHIRPing and the superlattice taught by the Song/Chow/Razeghi references. The Applicant would also like to respectfully point out to the Board that the Ohta patent clearly does not disclose the AlGaN/GaN superlattice base layer. For these reasons and all of the above reasons the Board is respectfully requested to reverse the Examiner's rejection of claims 2-4, 10 and 11.

Conclusion

The Board is respectfully requested to reverse the rejection of all claims by the Examiner.

Respectfully Submitted,

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Date: Jan 20, 04

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Appendix A
Claims On Appeal

1. A heterojunction bipolar transistor (HBT) comprising:

a substrate;

an n+ doped GaN subcollector layer;

an n- doped GaN collector layer;

a p+ doped base layer formed on top of said collector layer defining a base collector interface formed from alternating layers of A1GaN/GaN forming a superlattice;

an n+ doped A1GaN emitter layer formed on top of said base layer defining an emitter base interface;

a base contact formed on said base layer;

a collector contact formed on said subcollector; and

an emitter contact formed on said emitter.

2. The HBT as recited in claim 1, wherein the Al concentration in said AlGaN layers is irregular.

3. A heterojunction bipolar transistor (HBT) comprising:

a substrate;

an n+ doped GaN subcollector layer;

an n- doped GaN collector layer;

a p+ doped base layer formed on top of said collector layer defining a base collector interface formed from alternating layers of A1GaN/GaN forming a superlattice;

an n+ doped A1GaN emitter layer formed on top of said base layer defining an emitter base interface, the A1 concentration at said emitter base interface being greater at said emitter base interface than said base collector interface;

a base contact formed on said base layer;

a collector contact formed on said subcollector; and

an emitter contact formed on said emitter.

4. The HBT as recited in claim 1, wherein said alternating AlGaN layers are formed such that the A1 concentration is graded.

5. A heterojunction bipolar transistor (HBT) comprising:

a substrate formed from a material selected from the group consisting of sapphire and silicon carbide;

an n+ doped GaN subcollector layer;

an n- doped GaN collector layer;

a p+ doped base layer formed on top of said collector layer defining a base collector interface formed from alternating layers of A1GaN/GaN forming a superlattice;

an n+ doped A1GaN emitter layer formed on top of said base layer defining an emitter base interface;

a base contact formed on said base layer;

a collector contact formed on said subcollector; and

an emitter contact formed on said emitter.

8. A method for fabricating a heterojunction bipolar transistor comprising the steps:

(a) forming a subcollector layer on a substrate;

(b) forming a collector layer on said collector layer;

(c) forming a base layer as a superlattice of alternating layers of A1GaN/GaN on said collector defining a base collector interface; said base layer formed with an irregular band gap energy;

(d) forming an emitter layer on said base layer defining a base collector interface; and

(e) forming contacts on said base, subcollector said emitter layers.

9. A method for fabricating a heterojunction bipolar transistor comprising the steps:

(a) forming a subcollector layer on said substrate;

(b) forming a collector layer on said subcollector layer;

(c) forming a base layer comprising a superlatice of alternating layers of A1GaN/GaN having a non-constant concentration of A1 in said alternating layers of A1GaN/GaN on said collector defining a base collector interface; said base layer formed with an irregular band gap energy;

(d) forming an emitter layer on said base layer defining a base collector interface; and

(e) forming contacts on said base, subcollector said emitter layers.

10. The process as recited in claim 9, wherein step (c) comprises forming said base layer with an A1 concentration at said base collector interface being less than the A1 concentration at said base emitter interface.

11. A method for fabricating a heterojunction bipolar transistor comprising the steps:

(a) forming a subcollector layer on a stubstrate;

(b) forming a collector layer on said subcollector layer;

(c) forming a base layer comprising a superlattice of alternating layers of AlGaN/GaN having a non-constant concentration on Al in said alternating layers of AlGaN/GaN on said collector defining a base collector interface such that the Al concentration is graded between said base collector inerterface and said emitter base interface said base layer formed with an irregular band gap energy;

(d) forming an emitter layer on said base layer defining a base emitter interface; and

(e) forming contacts on said base, subcollector and emitter layers.